RESEARCH ARTICLE

Lack of Health Insurance Increases All Cause and All Cancer Mortality in Adults: An Analysis of National Health and Nutrition Examination Survey (NHANES III) Data

Min Rex Cheung

Abstract

Background: Public use National Health and Nutrition Examination Survey (NHANES III) and NHANES III linked mortality data were here applied to investigate the association between health insurance coverage and all cause and all cancer mortality in adults. Patients and Methods: NHANES III household adult, laboratory and mortality data were merged. Only patients examined in the mobile examination center (MEC) were included in this study. The sampling weight employed was WTPFEX6, SDPPSU6 being used for the probability sampling unit and SDPSTRA6 to designate the strata for the survey analysis. All cause and all cancer mortalities were used as binary outcomes. The effect of health insurance coverage status on all cause and all cancer mortalities were analyzed with potential socioeconomic, behavioral and health status confounders. Results: There were 2398 sample persons included in this study. The mean age was 40 years and the mean (S.E.) follow up was 171.85 (3.12) person months from the MEC examination. For all cause mortality, the odds ratios (significant p-values) of the covariates were: age, 1.0095 (0.000); no health insurance coverage (using subjects with health insurance), 1.71 (0.092); black race (using non-Hispanic white subjects as the reference group) 1.43, (0.083); Mexican-Americans, 0.60 (0.089); DMPPIR, 0.82, (0.000); and drinking hard liquor, 1.014 (0.007). For all cancer mortality, the odds ratio (significant p-values) of the covariates were: age, 1.0072 (0.00); no health insurance coverage, using with health coverage as the reference group, 2.91 (0.002); black race, using non-Hispanic whites as the reference group, 1.64 (0.047); Mexican Americans, 0.33 (0.008) and smoking, 1.017 (0.118). Conclusion: There was a 70% increase in risk of all cause death and almost 300% of all cancer death for people without any health insurance coverage.

Keywords: NHANES III - health insurance - all cause mortality - cancer mortality - disparity

Asian Pacific J Cancer Prev, **14 (4)**, 2259-2263

Introduction

Institute of medicine reported that having no health insurance was related to an excess death in adults (Medicine, 2002). There was also a large unmet health care need of uninsured patients (Ayanian et al., 2000). Health insurance has been shown to be related to all cause mortality using NHANES III and NHNAES III linked mortality data (Wilper et al., 2009). In other studies, National Health and Nutritional Examination Survey (NHANES) III public use data have been used to identify potential associations between cancer pathogenesis and mortality from factors such as dietary intakes (Cui et al., 2004), life-style (Shiels et al., 2009), dietary supplement use (Tseng et al., 2005), obesity (Rohrmann et al., 2007; Parekh et al., 2010), and environmental exposure to toxins such as boron (Cui et al., 2004). However, it is not clear if health insurance coverage status increases cancer related mortality. This study, was a part of a series, used the NHAMNES III and NHANES III linked mortality data to investigate the relationship between the status of having health insurance and all cancer mortality as well as all cause mortality. This study took advantage of the vastness of the NHANES III data to adjust for important socio-economic, behavioral, and health status factors (Cheung, 2012) that may cofound the effects of having health insurance on all cancer and all cause mortality.

Materials and Methods

NHANES and NHANES III

NHANES was a major program of National Center of Health Statistics (a part of Center of Disease Control (CDC) of United States of America) started in 1971. NHANES III was a national study based on a complex, multi-stage probability sampling design. For details of NHANES data and statistical guidance as well as their analysis examples see NHANES website (http://www.cdc.

*275 S Bryn Mawr Ave, K43, Bryn Mawr, PA *For correspondence: cheung.r100@gmail.com*

gov/nchs/nhanes.htm). In brief, NHANES studies were approved by CDC internal institutional review boards. The public use data were made available to the public and researchers. The NHANES sample weights were calculated to represent non-institutionalized general US population to account for non-coverage and non-response. These patients were interviewed at home and examined in mobile examination centers (MEC). In this study, NHANES III (conducted between1988-1994) household adult data file was merged with NHANES III laboratory data and the NHANES III linked cancer mortality data.

NHNAES III linked mortality data

NHANES III participants were followed passively until December 31, 2006 for their mortality data. Detailed information about the data and analysis guidelines are available at their website (http://www.cdc.gov/nchs/data_access/data_linkage/mortality/nhanes3_linkage.htm). In brief, probability matching was used to link NHANES III with National Death Index for vital status and mortality. NHANES used multiple sources including the use of death certificates and with the National Death Index to ascertain vital status and cause of death.

Statistical analysis

NHANES III employed a complex sampling strategy and analysis (Ezzati-Rice and Murphy, 1995; Graubard and Korn, 1999; Lemeshow and Cook, 1999; Chang et al., 2010). Matlab programs (posted on Matlab File Exchange) were developed to convert SAS files provided by NAHNES to STATA programs to download NHANES III data files for further analysis. The NHANES III household adult, NHANES III linked mortality, and laboratory data files were merged according to the SEQN number provided by NHANES III to uniquely identify the cases. Specialized survey software was needed for NHANES complex data analysis (Cohen, 1997). STATA 12 (College Station, TX) was among those recommended by CDC to analyze the complex NHANES data and was used in this study. Only patients examined in the mobile examination center (MEC) were included in this study to eliminate the confounding effects of the inability to go to the MEC because of poor health, very young or old age. The sampling weight used was WTPFEX6. SDPPSU6 was used for the probability sampling unit (PSU) and SDPSTRA6 was used to designate the strata for the STATA survey commands. STATA scripts were written for this analysis, and will be submitted for publication separately. Univariate and multivariate logistic regressions (Jewell, 2004) were used to study the relationship between health insurance coverage status (HFB11) and all cause, all cancer mortalities. The status of mortality was coded as a binary outcome (1=death, 0=otherwise). Linearized Taylor Standard Error estimation was used. The covariates and the corresponding NHANES III codes (when applicable) used were: BMI (body mass index, kg/m^2), MXPAXTMR (age at the MEC final examination in months), HSSEX (sex, _IHSSEX_1=male, female as the reference group), HAM5S (height in inches without shoes), HAM6S (weight in lbs without clothes and shoes), DMPMETRO (USDA urban rural residence status, _IDMPMETRO_2=rural residence, urban residence was used as the reference group), DMARETHN (race and ethnicity, _IDMARETHN_2 =non-Hispanic black, _IDMARETHN_3=Mexican Americans, _IDMARETHN_4=others, non-Hispanic white was used as the reference group), DMPPIR (poverty index ratio), HAN6JS (alcohol consumption, number of hard liquor drinks per month), and HAR4S (smoking, number cigarettes per day).

For STATA analyses, only the patients without missing values for all of WTPFEX6, SDPPSU6, SDPSTRA6, BMI, MXPAXTMR, HSSEX, HFB11, DMPMETRO, HAM5S, HAM6S, DMARETHN, DMPPIR, HAR4S, and HAN6JS were included in this study. Further, these additional NHANES III codes considered not eligible: outside of BMI>15 & BMI<50, HFB11(<8), HAM5S (888), HAM5S(999), HAM6S (888), HAM6S (999), DMPPIR (888888, also note that the numerator of DMPPIR was the midpoint of the observed family income category in the Family Questionnaire variable:HFF19R, and the denominator was the poverty threshold, the age of the family reference person, and the calender year in which

Table 1. Demographic, Socioeconomic and other Univariables for all Cause Mortality and all Cancer Mortality

Outcome and Covariates	NHANES III Code	Category	Value	Std Err.	95% Confidence Interval
All cause death		All cause death=1 (n=5291) Otherwise=0 (n=28703)	0.15	0.0100	0.13-0.170
All cancer death		All cancer death=1 (n=1117) Otherwise=0 (n=32877)	0.047	0.0052	0.037-0.058
Health Insurance	HFB11	Covered=1	12655		
		Not covered=2	1291		
Age in months at MEC exam	MXPAXTMR		480.37	4.9900	470.36-490.390
Sex	HSSEX	Men=1	9401		
		Women=2	10649		
Body Mass Index			25.1	0.1600	24.77-25.420
Rural/urban code	DMPMETRO	Urban=1	9979		
based on USDA code		Rural=2	10071		
Race-ethnicity	DMARETHN	Non-Hispanic white=1	8483		
		Non-Hispanic black=2	5486		
		Mexican American =3	5306		
		Other=4	775		
Poverty Income Ratio (unimputed income)	DMPPIR		3.11	0.0720	2.96-3.250
Hard liquor-times/month	HAN6JS		3.12	0.3600	2.40-3.840
# cigarettes smoked per day	HAR4S		19.88	0.4400	18.99-20.770

Table 2. Univariate Logistic Regression of Covariates for NHNAES III All Cause Mortality and for NHNAES III All Cancer Mortality

		Odds Ratio	Linearized Std. Err.	t	P>|t|	95% Confidence Interval	
NHNAES III all cause mortality*							
IndicatorDeath:	BMI	1.0199800	0.0154466	1.31	0.198	0.9894069	1.0514990
	MXPAXTMR	1.0091030	0.0007081	12.91	0.000	1.0076810	1.0105270
	HSSEX	0.8857521	0.1111523	-0.97	0.338	0.6883222	1.1398100
	HFB11	0.8687683	0.2228841	-0.55	0.586	0.5187989	1.4548190
	DMPMETRO	1.0629860	0.1649167	0.39	0.696	0.7782610	1.4518770
	DMARETHN	1.0288690	0.0960468	0.30	0.762	0.8528793	1.2411740
	DMPPIR	0.9158188	0.0309322	-2.60	0.012	0.8557208	0.9801375
	HAN6JS	1.0166040	0.0083825	2.00	0.051	0.9998976	1.0335900
	HAR4S	1.0079140	0.0065785	1.21	0.233	0.9947804	1.0212210
NHNAES III all cancer mortality**							
CancerDeath:	BBMI	1.0095960	0.0312658	0.31	0.759	0.9486800	1.0744230
	MXPAXTMR	1.0067220	0.0006415	10.51	0.000	1.0054330	1.0080120
	HSSEX	0.9988146	0.1810472	-0.01	0.995	0.6938872	1.4377420
	HFB11	1.4584780	0.4449900	1.24	0.222	0.7899867	2.6926510
	DMPMETRO	0.7689384	0.1585495	-1.27	0.209	0.5080862	1.1637130
	DMARETHN	1.0141860	0.2094932	0.07	0.946	0.6696387	1.5360130
	DMPPIR	0.9667410	0.0607300	-0.54	0.593	0.8520886	1.0968200
	HAN6JS	1.0089450	0.0049827	1.80	0.077	0.9989819	1.0190080
	HAR4S	1.0158240	0.0091950	1.73	0.089	0.9975133	1.0344710

*IndicatorDeath: 0=alive, 1=death from any cause. Linearized Taylor Standard Error; estimation was used. Codes used were: BMI (body mass index), MXPAXTMR (age at the MEC; final examination), HHSSEX (sex), FB11 (any health insurance coverage), DMPMETRO (urban rural residence status), DMARETHN (race and ethnicity), DMPPIR (poverty index ratio), HAN6JS (alcohol consumption), and HAR4S (smoking). n=2398 sample persons. **cancerDeath: 0= alive or dead from non-cancer causes, 1=death from any cancers. Linearized Taylor Standard Error estimation was used. Codes used were: BMI (body mass index), MXPAXTMR (age at the MEC final examination), HHSSEX (sex), FB11 (any health insurance coverage), DMPMETRO (urban rural residence status), DMARETHN (race and ethnicity), DMPPIR (poverty index ratio), HAN6JS (alcohol consumption), and HAR4S (smoking). n=2398 sample persons

the family was interviewed) HAR4S (666), HAR4S (777), HAR4S (888), HAR4S (999), HAN6JS (888), HAN6JS (999). A total of 2398 sample persons were eligible for this study. Dummy variables were used in multivariate analyses, but not in the screening univariate analyses. For HFB11, multivariate analysis was performed with a dummy variable for HFB11 (using sample persons with health insurance as the reference group) and one without using a dummy variable.

Results

There were 5291 all cause and 1117 all cancer deaths out of a total of 33994 sample persons (Table 1). All cancer mortality (using ucod_113 codes, 1117 deaths were counted out of 33994 subjects). There were 12665 sample persons covered by any health insurance (government or private), there were 1291 sample persons not covered. There were 9401 men and 10649 women included in this study. The mean (S.E.) follow up was 171.85 (3.12) person months from the MEC examination. The mean body mass index (BMI) (S.E.) was 25.1 (0.16). There were 9979 urban and 10071 rural residents. There were 8483 non-Hispanic whites, 5486 non-Hispanic blacks, 5306 Mexican Americans and 775 subjects of other races and ethnicity. The mean poverty income ratio (S.E.) was 3.11 (0.072). The number of glasses of hard liquors (S.E.) drank by the subjects was 3.12 (0.36) and number of cigarettes (S.E.) smoked per day was 19.88 (0.44).

There were 2398 sample persons with complete data for all the covariates included in this study. The mean age was 40 years old. For the univariate logistic regression for NHNAES III all cause mortality (Table 2), the covariates, and odds ratios (significant p-values) were: age, 1.009 (0.000); poverty income ratio (DMPPIR), 0.92 (0.012); drinking, 1.017 (0.051). For the multivariate logistic regression of for the NHANES III all cause mortality (Table 3), the covariates, and odds ratios (significant p-values) were: age, 1.0095 (0.000); no health insurance coverage (using subjects with health insurance as the reference), 1.71 (0.092); black race (using non-Hispanic white subjects as the reference group), 1.43 (0.083); Mexican-Americans, 0.60 (0.089); DMPPIR, 0.82, (0.000); and drinking hard liquor, 1.014 (0.007).

For the univariate logistic regression for NHNAES III all cancer mortality (Table 2), the covariates, and odds ratios (significant p-values) were: age, 1.0067 (0.000); drinking hard liquor, 1.0089 (0.077); and smoking, 1.016 (0.089). For the multivariate logistic regression of for the NHANES III all cancer mortality (Table 3), the covariates, and odds ratio (significant p-values) were: age, 1.0072 (0.00); having no health insurance coverage (using with health coverage as the reference group), 2.91 (0.002); black race (using non-Hispanic whites as the reference group), 1.64 (0.047); Mexican Americans, 0.33 (0.008) and smoking, 1.017 (0.118).

Discussion

Although the relationship between having health insurance and cancer mortality needs further investigation, there are studies suggesting a large effect of having health insurance on health outcome (Ayanian et al., 2000; Medicine, 2002). Previous studies have suggested that having health insurance decreased all cause mortality using NHANES III and NHNAES III linked mortality data

Table 3. Multivariate Analysis of NHANES III linked All Cancer Mortality

		Odds Ratio	Linearized Std. Err.	t	P>|t|	95% Confidence Interval	
NHNAES III all cause mortality*							
IndicatorDeath:	BMI	1.0269340	0.0178142	1.53	0.132	0.9917517	1.0633640
	MXPAXTMR	1.0094870	0.0007087	13.45	0.000	1.0080640	1.0109130
	IHSSEX_2	0.7897941	0.1365381	-1.37	0.178	0.5580009	1.1178740
	IHFB11_2	1.7063880	0.5302831	1.72	0.092	0.9138180	3.1863670
	IDMPMETRO2	0.9549926	0.1471138	-0.30	0.766	0.7007383	1.3015000
	IDMARETHN2	1.4275740	0.2869153	1.77	0.083	0.9532199	2.1379840
	IDMARETHN3	0.5958434	0.1778689	-1.73	0.089	0.3270415	1.0855790
	IDMARETHN4	1.2148110	0.6246822	0.38	0.707	0.4322384	3.4142430
	DMPPIR	0.8210756	0.0346220	-4.68	0.000	0.7543664	0.8936839
	HAN6JS	1.0136940	0.0048884	2.82	0.007	1.0039180	1.0235660
	HAR4S	1.0008470	0.0100398	0.08	0.933	0.9808727	1.0212270
	cons	0.0008039	0.0005945	-9.64	0.000	0.0001819	0.0035528
NHNAES III all cancer mortality**							
CancerDeath:	BMI	1.0141770	0.0327130	0.44	0.664	0.9505230	1.0820940
	MXPAXTMR	1.0072290	0.0007372	9.84	0.000	1.0057480	1.0087110
	IHSSEX_2	1.0276470	0.2117515	0.13	0.895	0.6792192	1.5548110
	IHFB11_2	2.9084810	0.9575813	3.24	0.002	1.5008080	5.6364740
	IDMPMETRO2	0.6817699	0.1703322	-1.53	0.132	0.4126598	1.1263760
	IDMARETHN2	1.6404030	0.3978581	2.04	0.047	1.0075740	2.6706920
	IDMARETHN3	0.3265727	0.1322615	-2.76	0.008	0.1447166	0.7369558
	IDMARETHN4	1.2470480	1.2017490	0.23	0.820	0.1798202	8.6482460
	DMPPIR	0.9422903	0.0650756	-0.86	0.394	0.8201851	1.0825740
	HAN6JS	1.0013780	0.0045668	0.30	0.764	0.9922424	1.0105970
	HAR4S	1.0169570	0.0107457	1.59	0.118	0.9955900	1.0387820
	cons	0.0004479	0.0004581	-7.54	0.000	0.0000574	0.0034977

*IndicatorDeath: 0=alive, 1=death from any cause. Linearized Taylor Standard Error estimation was used. The codes used were: BMI (body mass index), MXPAXTMR; (age at the MEC final examination), HAM6S (weight in lbs without clothes), DMPMETRO; (urban rural residence status, _IHSSEX_2=female sex, male sex used as the reference,; _IHFB11_2=not covered by health insurance, using covered by health insurance as the reference, _IDMPMETRO_2=rural residence, urban residence used as the reference group), DMARETHN (race and ethnicity, _IDMARETHN_2=non-Hispanic black, _IDMARETHN_3=Mexicans, _IDMARETHN_4=others, non-Hispanic white used as the reference group), DMPPIR (poverty index ratio), HAN6JS (alcohol consumption), and HAR4S (smoking). n=2398 sample persons. **CancerDeath: 0=alive or dead from non-cancer causes, 1=death from any cancers. Linearized Taylor Standard Error estimation was used. The codes used were: BMI (body mass index), MXPAXTMR (age at the MEC final examination), HAM6S (weight in lbs without clothes), DMPMETRO (urban rural residence status, _IHSSEX_2=female sex, male sex used as the reference, _IHFB11_2=not covered by health insurance (using covered by health insurance as the reference), _IDMPMETRO_2=rural residence, urban residence used as the reference group), DMARETHN (race and ethnicity, _IDMARETHN_2=non-Hispanic black, _IDMARETHN_3=Mexicans, _IDMARETHN_4=others, non-Hispanic white used as the reference group), DMPPIR (poverty index ratio), HAN6JS (alcohol consumption), and HAR4S (smoking). n=2398 sample persons

(Wilper et al., 2009). In that study, having health insurance was defined as having private health insurance. In this study, having health insurance was defined as having any health insurance. Having health insurance has also been shown to be related to the treatment outcome of trauma elderly patients (Singer et al., 2013) and the outcome of post operative patients with brain tumor surgery (Momin et al., 2012). Having health insurance has been shown to improve the elder patients' outcome in Taiwan (Momin et al., 2012), and decrease health disparity (Arroyave et al., 2013). The outcome of hospital care in Thailand was related to the types of patients' health insurance coverage (Reungjui et al., 2012). National health insurance also affected the health status of people in general (Odeyemi and Nixon, 2013). This study used NHANES III household adult and NHANES III linked mortality data to investigate the relationship between health insurance coverage and all cancer mortality and all cause mortality (Table 1).

This study found age, poverty income ratio and drinking were important univariables for all cause mortality (Table 2). From multivariate logistic regression, age, having no health insurance coverage, black race (using non-Hispanic white subjects as the reference group), Mexican-Americans, poverty income ratio and drinking hard liquor remained significant predictors after adjusting for the other socioeconomic, behavioral and health status variables (Table 3). All the univariables were used in the final multivariate logistic regression to obtain a more conservative estimate of the effect of having health insurance on all cause mortality by adjusting for potential confounders directly. When the magnitudes of the risks, or when there were significant prior studies on the risk factors related to worse health outcomes (Jewell, 2004; 2009; Rothman et al., 2008). In the present study, p-values slightly higher than 0.05 were also considered significant for these factors.

This study found age, drinking hard liquor and smoking were significant univariables (Table 2). Under multivariate logistic regression (Table 3), the significant and independent predictors were age, having no health insurance coverage (using with health coverage as the reference group), black race (using non-Hispanic whites as the reference group), Mexican Americans, and smoking. Taken together, there was a 70% increase in risk of all cause mortality associated with no health insurance (Table 3). In addition, there was an almost 300% increase in all cancer mortality associated with no health insurance coverage (Table 3). This is a very significant effect of having any health insurance on all cause, and all cancer mortality. Thus providing universal health insurance coverage as suggested by the US government may remove this disparity.

References

Arroyave I, Cardona D, Burdorf A, Avendano M (2013). The impact of increasing health insurance coverage on disparities in mortality: health care reform in colombia, 1998-2007. *Am J Public Hlth*, **103**, 100-6.

Ayanian JZ, Weissman JS, Schneider EC, Ginsburg JA, Zaslavsky AM (2000). Unmet health needs of uninsured adults in the United States. *JAMA,* **284**, 2061-9.

Chang SL, Harshman LC, Presti JC (2010). Impact of common medications on serum total prostate-specific antigen levels: analysis of the national health and nutrition examination survey. *J Clin Oncol*, **28**, 3951-7.

Cheung R (2012). Poor treatment outcome of neuroblastoma and other peripheral nerve cell tumors may be related to under usage of radiotherapy and socio-economic disparity: a US SEER data analysis. *Asian Pac J Cancer Prev,* **13**, 4587-91.

Cohen SB (1997). An evaluation of alternative PC-based packages for the analysis of complex survey data. *Am Statistician,* **51**, 285-92.

Cui Y, Winton MI, Zhang ZF et al (2004). Dietary boron intake and prostate cancer risk. *Oncol Rep,* **11**, 887-92.

Ezzati-Rice TM, Murphy RS (1995). Issues associated with the design of a national probability sample for human exposure assessment. *Environ Health Perspect,* **103**, 55-9.

Graubard BI, Korn EL (1999). Analyzing health surveys for cancer-related objectives. *J Natl Cancer Inst*, **91**, 1005-16.

Jewell NP (2004). Statistics for Epidemiology (Boca Raton, Florida, Champman and Hall/CRC).

Jewell NP (2009). Risk interpretation, perception, and communication. *Am J Ophthalmol,* **148**, 636-8.

Lemeshow S, Cook ED (1999). Practical considerations in the analysis of complex sample survey data. *Rev Epidemiol Sante Publique*, **47**, 479-87.

Medicine, Io (2002). Care Without Coverage, Too Little, Too Late (Washington, DC).

Momin EN, Adams H, Shinohara RT et al (2012). Postoperative mortality after surgery for brain tumors by patient insurance status in the United States. *Arch Surg*, **147**, 1017-24.

Odeyemi IA, Nixon J (2013). Assessing equity in health care through the national health insurance schemes of Nigeria and Ghana: a review-based comparative analysis. *Int J Equity Hlth*, **12**, 9.

Parekh N, Lin Y, Dipaola RS, Marcella S, Lu-Yao G (2010). Obesity and prostate cancer detection: insights from three national surveys. *Am J Med*, **123**, 829-35.

Reungjui S, Anunnatsiri S, Limwattananon C, et al (2012). Health insurance system and healthcare provision: nationwide hospital admission data 2010. *J Med Assoc Thai,* **95**, 240-53.

Rohrmann S, Giovannucci E, Smit E, Platz EA (2007). Association of IGF-1 and IGFBP-3 with lower urinary tract symptoms in the third national health and nutrition examination survey. *Prostate,* **67**, 1693-8.

Rothman KJ, Greenland S, Lash TL (2008). Modern Epidemiology, 3rd edn (Philadelphia, Pennsylvania, Lippincott Williams and Wilkins).

Shiels MS, Rohrmann S, Menke A, et al (2009). Association of cigarette smoking, alcohol consumption, and physical activity with sex steroid hormone levels in US men. *Cancer Causes Control,* **20**, 877-86.

Singer MB, Liou DZ, Clond MA, et al (2013). Insurance-and race-related disparities decrease in elderly trauma patients. *J Trauma Acute Care Surg* **74**, 312-6.

Tseng M, Breslow RA, Graubard BI, Ziegler RG (2005). Dairy, calcium, and vitamin D intakes and prostate cancer risk in the national health and nutrition examination epidemiologic follow-up study cohort. *Am J Clin Nutr*, **81**, 1147-54.

Wilper AP, Woolhandler S, Lasser KE et al (2009). Health insurance and mortality in US adults. *Am J Public Hlth*, **99**, 2289-95.